The University of Michigan • Office of Research Administration
Ann Arbor, Michigan

May 21, 1965 05863-8-P

National Aeronautics and Space Administration
Office of Grants and Research Contracts
Code SC
Washington, D.C. 20546

Attention: Dr. T. L. K. Smull, Director

Gentlemen:

This is the 8th quarterly progress report on contract No. NASr-54(03), covering the period November 1, 1964 to January 31, 1965.

The project effort during this quarter was divided among the following 5 tasks.

1. Analysis of data obtained on previous balloon flights.
2. Design, construction and testing of equipment for the next balloon flight.
3. Analytical study of atmospheric radiation processes.
4. Development of an infrared interferometer for spacecraft use.
5. Report writing.

The interferometer development and preparations for the next balloon flight were of primary concern during this quarter. Details of the progress in each of the above 5 areas of work are given below.

1. Analysis of Data Obtained on Previous Balloon Flights

The analysis of the 26 June, 1963 balloon flight data continued.

The data for the two visible channels of the TIROS 5 channel radiometer were completely processed and plotted.

Work continued on the IBM 7090 computer program for processing the NIMBUS MRIR data.

Plans were laid for the processing of data from the next balloon flight, to try to eliminate the usual long delay between balloon flight and completion of data processing

2. Design, Construction and Testing of Equipment for the Next Balloon Flight

The design, construction and testing of equipment for use on the next balloon flight continued as follows.

A base plate which will be used for the assembly of the SIRS spectrometer and space reference body was designed. It will be made of a "sandwich" of rigicell foam and magnesium to obtain the required stiffness with very light weight.

A thermally insulated compartment with motor driven door was designed to house the NIMBUS MRIR radiometer on the balloon gondola. This compartment will insure that the radiometer remains within its operating temperature limits while the gondola passes through the tropopause. The door will be opened after the balloon is above the tropopause and will close before the gondola descent begins.

Brackets and fastening devices for the Vonnegut cloud photography camera, for the Weather Bureau Horizon Camera, for several electronics chasses and for the free air temperature thermistors were constructed.

Electrical and electronic devices completed included regulated thermistor power supplies, a photocell power supply and 2 power supplies which will be used to supply timing signals for the control of analog to digital conversion equipment during the balloon flight.

The balloon gondola electrical control and timing equipment was modified to meet various changes in data taking requirements. Modules for use in data sampling and digitizing were ordered.

Two of the Maurer aerial cameras were modified. The lens was changed on one and a small lamp was installed in the other so that coded time signals can be recorded directly on the photographs.

Because the new VCOs ordered for use on the next balloon flight will not be delivered in time for use on that flight, an operational amplifier unit was constructed containing inverters and summing devices to match signal source output voltages to existing VCOs.

The new time code generator was found to be defective. A replacement oscillator was obtained to correct the trouble.

The CP-100 Ampex tape recorder was serviced by a factory engineer who found that the tape tracking was indeed out of adjustment. After adjustment by the serviceman the CP-100 Ampex and P5-207 Precision Instruments tape recorders where found to be completely compatible for recording and playback.

The telemetry receiving system pre-amplifier was found to have much too high a signal to noise ratio. A new tube was installed and adjustments were made.

Early in January, a meeting was held at Goddard Space Flight Center with NASA and U. S. Weather Bureau personnel to set a date for the next balloon flight. It was decided that early March would be desirable. The NIMBUS MRIR (5 channel radiometer), the SIRS spectrometer and the JPL

spectrometer will be flown. The infrared interferometer will not be flown since it is not sufficiently developed at this time.

3. Analytical Study of Atmospheric Radiation Processes

The report on the results of the calculation of slant path transmissirities for the 15 micron CO_2 band was published and distributed (see section 5).

The work on modification and improvement of the programs for calculating 15 micron CO_2 transmissivities has continued. The modification for computing homogeneous path transmissivities was completed and the results were compared with laboratory measurements with reasonable agreement. The remainder of the work was aimed at developing a more flexible, accurate and efficient program. Initially the emphasis will be on homogeneous paths, so that results can be readily compared with laboratory measurements. This program will allow line half-width to be varied as a function of rotational quantum number.

4. Development of an Infrared Interferometer for Spacecraft Use

Modification and testing of the scientific breadboard has continued. During this experimental study of the operating characteristics of the instrument, changes have been made and many problems have been discovered and some have been solved. The operation was always marginal in signal to noise ratio. Thus although a significant improvement in the instrument performance has not resulted from the work in this period, many problems have been solved and understanding of the instrument properties has increased remarkably. Details of the work follow.

It has been found that the beam splitter cannot be clamped in any manner without introducing significant distortion. After various clamping techniques were tried without success, mechanical clamping was abandoned in favor of gluing. The technique of gluing with pliobond cement diluted with methyl ethyl ketone was developed with very good results. The beam splitter and compensating plate thus assembled worked very satisfactorily in the interferometer. A modified (improved?) solution to be tried in the near future will be to glue the KBr substrate to a plastic holder having the same coefficient of thermal expansion. The KBr will then be polished after gluing.

The problem of distortion of the Michelson mirror was also solved by use of the pliobond cement technique. Other methods of fastening or holding the mirror including the use of thin spring clips, screws or gluing with epoxy all caused excessive distortion. Again it is proposed that in the future the mirror be glued to its holding device before polishing.

Auxiliary experiments and tests included more investigations of SiO and MgF_2 as protective coating for the KBr beam splitter (samples did not survive NIMBUS environmental test specifications), more investigations of neon lamps for use in the visible monochromatic beam, tests of a new silicon detector for this monochromatic signal, measurements of transmission and reflection of

the KBr beam splitter in the visible region of the spectrum, measurements of the noise figure of the Ithaco amplifiers, and testing of a 4 channel Lockheed tape recorder borrowed from the U. S. Weather Bureau for use in recording interferograms.

Two informal reports, an interferometer specification and a description of the scientific breadboard were written and turned over to NASA GSFC personnel.

Many items were fabricated and constructed. These included engineering breadboard optical cubes, optical cone masters and the internal magnet drive unit.

Attempts were made to package the electronic breadboards supplied by NASA GSFC personnel. These attempts were unsuccessful in that they produced serious problems in operation due to switching transient interference. The electronic units have been restored to their breadboard style for the present so that other work may proceed.

Some work has been done on the assembly of equipment to be used in a vacuum interferometer calibration system.

Finally an extensive study was begun of the data processing technique to produce spectra from interferograms.

5. Report Writing

Two papers were presented at the Third Symposium on Remote Sensing of Environment at The University of Michigan on October 14, 15, 16. (These were inadvertantly not reported in the last progress report). The papers were: "Earth Radiation Measurements by Interferometer from a High Altitude Balloon," by L. W. Chaney and "Infrared and Visible Radiation Measurements by Radiometer on High Altitude Balloon Flights at 34 km Altitude," by F. L. Bartman.

The report "Atmospheric Slant Path Transmission in the 15μ CO_2 Band," by S. Roland Drayson, University of Michigan ORA report no. 05863-6-T, November 1964 was submitted to NASA and was distributed.

6. Summary of Future Work

The following tasks will receive major attention during the next quarter.

a. Development of the infrared interferometer.

b. Analyses of data from previous balloon and aircraft flight tests.

c. The next balloon flight tests.

d. Analytical study of atmospheric radiation processes

e. Report writing.